

## THE ROLE OF SHRUBS IN SOME PLANT COMMUNITIES OF THE BOGONG HIGH PLAINS

By STELLA G. M. CARR

### Introduction

Many of those with a long acquaintance with the Bogong High Plains are of the opinion that shrubs have become more numerous there over at least the last 20 years. This observation has been shown to be correct by (a) comparison of the present-day distribution of shrubs with aerial photographs taken in 1938 (State Electricity Commission of Victoria) and 1945 (Department of Lands and Survey, Victoria, 1950) and (b) by measurements made over the period 1945-1959 (Carr and Turner unpublished data). The increase in shrubs (which are not grazed) at the expense of edible herbage is causing concern to some run-holders and is important from another point of view. On the alpine plateaux of the State, all of which show the tendency, vegetation in which shrubs are dominant or numerous presents a greater fire-hazard than does vegetation in which grasses and herbs predominate. Further, once they are burnt, shrubs are slow to recover and soil losses are severe and continue for many years. Shrub (or scrub) understoreys are also a current problem in the woodlands and forests of the slopes leading up to the high plains, but in this paper it is intended to deal only with the plant communities of the open tops.

Although the increase in the area occupied by shrubs has been considerable, not all of the plant communities have been affected by it. The mossbeds, the vegetation of which is predominantly woody, have certainly not extended. In the broad sweep of the herbfields, minute isolated shrubs persist, but are unable to make normal growth because they are trampled by grazing stock (Carr and Turner 1959). The same is true of the snow patches. On the other hand, many of the old-established shrub communities characteristic of rocky sites have become denser and have also extended at the expense of adjacent grassland and herbfield. In the grasslands and snow gum woodlands, isolated shrubs and clumps of shrubs have appeared in large numbers where shrubs were formerly few and scattered. In some cases, grassland has been replaced by continuous shrub communities.

### The Shrub Flora of the High Plains

Excluding very rare species, the flora of the high plains consists of about 160 species of higher plants. Of these, 34 are shrubs, most of which are restricted to alpine and subalpine areas. Few of the other shrub species (wides) which also occur elsewhere in the State at lower elevations are of importance in the vegetation of the high plains. *Hovea longifolia* is very common on well-drained soils, particularly in grassland and snow gum woodland. It is an aggressive species and tolerates severe wind pruning. *Epacris paludosa* is confined to mossbeds but is a very common species in them. *Epacris microphylla* is a common species in herbfields at high elevations and also occurs on intermittently wet ground from about 5,400 ft upwards. The other species of the group are of widespread occurrence on well-drained sites but they appear only in situations which offer sheltered or

otherwise special conditions. None of them is aggressive. A list of the wides with notes on their field behaviour is given in Table 1.

TABLE 1

List of shrub species which occur on the high plains but are not restricted to alpine regions, with notes on their field behaviour

Species	High Plains	Lowland
<i>Epacris microphylla</i> R. Br.	On intermittently wet soil from 5500 ft upwards; also in herbfield at 5800 ft and upwards	Wet heathland
<i>E. paludosa</i> R. Br.	Mossbeds	Wet heathland
<i>Hovea longifolia</i> R. Br. in Ait. f.	General distribution on well-drained soils, very common in grassland and woodland. Tolerates wind-pruning.	Widely distributed in mountainous country
<i>Hymenanthera Dentata</i> R. Br. ex DC. var. <i>angustifolia</i> (R. Br. ex DC.) Benth.	General distribution on well-drained soils, common, but never seen in well-grown state. Occurs as dwarf, straggling plants among snow grass or as unthrifty espalier.	Widely distributed but chiefly riparian
<i>Pimelca axiflora</i> F. Muell. ex Meissn. var. <i>alpina</i> F. Muell. ex Benth.	Snow gum woodlands and grassland. Tolerates moderate wind-pruning.	Wet sclerophyll forests
<i>P. ligustrina</i> Labill.	Only in sheltered places, sometimes riparian.	Riparian and in wet sclerophyll forests

The shrub species which are restricted to the high plains can be arranged in a series according to the wetness of the soils they occupy (Table 2). It is not proposed to deal here with the shrubs characteristic of the mossbeds but to consider only those characteristic of better-drained and drier soils.

#### Characteristics and Field Behaviour of Shrubs

The species concerned have many features in common. Their leaves are small, thick and entire and on old shoots they are restricted to the upper parts of the stems where they are aggregated to form a dense canopy which varies in depth with the species. Immediately below the canopy there are usually many thin, dead branches but the lower portions of the stems are bare. Although in the field the shrubs are slow-growing and much-branched from the base, in cultivation they assume a single-stemmed habit. Only two species (*Hovea longifolia* and *Kunzea muelleri*) have been seen to produce roots from stems in the field. These will be referred to as 'rooting' species and the others as 'non-rooting'. In all species, if the upper parts of the plants are damaged or removed, new shoots grow out from the base of the stems.

The performance and shape of shrubs is much affected by wind-pruning. The prevailing wind is NW. and in all but the most sheltered positions isolated shrubs, clumps of shrubs and whole shrub-communities have uniform, dense canopies. Isolated shrubs and small clumps have a smooth, rounded profile. The rate of growth in height depends largely on the extent to which the plants are exposed to the prevailing wind. This may be illustrated by the following data for two species

neither of which tolerates extreme exposure. *Bossiaea foliosa* plants 18 years old, growing in a sheltered situation were 42 in. tall. Plants of the same age on exposed sites were between 12 and 15 in. in height. *Phebalium podocarpoides* plants growing in shelter ranged from 15 to 24 in. tall while those of the same age growing on exposed sites were between 10 and 12 in. high. At elevations of 5,400-5,800 ft shrubs well-established in grassland commonly project above the sward, but at higher elevations on NW. slopes any shrubs present (and they are often very numerous in herbfield vegetation at these altitudes) produce their wind-pruned canopies at the level of the top of the sward. They are capable of maintaining dense canopies only if the vegetation of the windward side remains intact. If the shelter is removed the branches on the windward side of the shrub die and the other branches become denuded of leaves except at their tips. On the eroded mountain tops characteristic of the alpine region shrubs grow very slowly and assume a prostrate habit. In the lee of rocks or tussocks growth is still slow but the stems are more leafy. The most successful species in such situations is *Kunzea muelleri*. It grows flat on the soil with its shoots parallel to one another and directed downwind.

The stems of all species are readily damaged by bruising. Branches so damaged usually die, possibly from excessive water loss through breaks in the cortex. The commonest cause of bruising is trampling by stock but similar effects can be produced by motor vehicles (Pl. XXXVIII, fig. 2). The most severe damage occurs where shrubs spread over rocky or eroded ground. The persistence of vehicle tracks, some of which were used only a few times many years ago, is readily perceived but the extent to which shrubs and shrub communities are affected by the trampling of cattle is not generally appreciated. In an earlier publication (Carr and Turner 1959) it was shown that trampling prevents the development of shrubs in herbfield communities of Pretty Valley. The effect of trampling on scattered shrubs is also shown clearly by comparison of the adjacent fenced and grazed areas at the NE. corner of the Rocky Valley plot. The enclosed area has been protected from stock since 1945. The increase in the size of the shrubs and the amount of shrub cover is not due to lack of grazing, as none of the shrubs is eaten by cattle.

### Regeneration from Seed

Most of the shrub species produce considerable quantities of seed with some regularity. Most species shed their seeds in the same season in which they are formed, others early in the following season. In most species the seed falls free of the fruit walls, notable exceptions being those of *Leucopogon* spp. and *Lissanthe montana*. Preliminary investigations have shown that not all species require a cold treatment for germination. Seedlings of the majority of species have been recorded in the field during 1941-1959 but very few have been seen at any one time. Whether or not they are more numerous after fire is not known. Protection from stock (1945-1959) has not resulted in any marked increase in numbers of seedlings although it does affect their chance of survival. Seedlings have never been observed growing together in large numbers. If they occur at all they are solitary or very widely spaced.

The very numerous ants (many of them harvesters) of the high plains may considerably reduce the numbers of seeds available for germination but it must also be taken into account that as seedlings can only establish on bare ground very considerable losses must occur between germination and establishment. At these elevations patches of bare ground constitute a difficult environment for ecesis. None of the perennial grasses and only one or two unimportant species of herbs can

colonize bare ground by other than vegetative means. In fact, vegetative propagation is a far more widespread phenomenon than seedling regeneration in this area. Regeneration of shrubs from seed is much affected by competition from established grasses, herbs or other shrubs. It follows that patches of bare ground below a certain minimum size (about 4 in. in diameter in most communities) are not colonized by shrubs. On the other hand, shrubs appear to have difficulty in becoming established on large patches of bare ground in windswept situations. Records have been kept of patches of bare ground (3-4 ft in diameter) which appeared after the 1939 fires and on which no seedlings of any kind have appeared. These patches are on NW. slopes at 5,600 ft. Some have been protected from stock, others not. Adjacent smaller patches of bare ground 9-15 in. in diameter, formed at the same time, have been colonized by shrubs. It appears that the amount of shelter provided by the grass sward, 4-6 in. high, which surrounds these smaller patches is sufficient to allow shrubs to become established.

### The Regeneration Cycle

The course of development followed by a seedling shrub or by the shoots which may arise from the crown of an older shrub, the overground parts of which have been destroyed, depends to a great extent on three factors. They are (a) the amount of competition, (b) the degree of wind-pruning, and (c) the amount of damage suffered during growth.

If competition is severe the young shrub is likely to remain dwarfed and suppressed by grasses, herbs or by other shrubs. Throughout the whole area it is common to find straggling, suppressed shrubs in apparently pure grassland and the majority of well-grown shrubs harbour suppressed individuals of at least one other shrub species. The suppressed shrubs grow very slowly but are nevertheless capable of surviving for at least 20 years. Watt (1947, 1955) has pointed out that, in the development of a shrub, certain phases may be recognized on the basis of characteristic changes in its morphology and vigour. On the high plains, if a young shrub is not subjected to severe competition, and if wind-pruning is moderate, its development follows the pattern described by Watt (1955) for *Calluna vulgaris*. It will increase in size through the pioneer and building phases until it reaches maturity. Maturity is followed by a phase of degeneration and in the extreme by death. Re-establishment by seed or by vegetative means may or may not follow. The canopy remains dense until maturity and as it extends laterally, already-established plants of grasses and most herb species become shaded and completely suppressed. However, once the shrub is well-grown the shelter provided by its canopy allows grass seedlings to become established.

Once the stage of maturity is past most shrubs become flat on top. The central, erect branches eventually lose vigour, become much less leafy and then die, leaving an opening in the centre of the shrub (Pl. XXXVIII, fig. 1). The opening enlarges centrifugally by the death of further branches. The dead branches fall outwards so that they come to lie over and among the living ones. Shrubs in the advanced degenerate phase commonly take on a bowl- or saucer shape. Ultimately only the prostrate branches remain alive. Their stems become overgrown by other plants and only the upturned ends bear leaves. The old shoots or 'non-rooting' species eventually die but the shoots of 'rooting' species keep on growing, their vigour depending on the severity of competition.

During the life-cycle of a shrub special environments exist beneath its canopy. The effect of a shrub in ameliorating the general conditions, small at first, increases as it grows to maturity. It then exerts a considerable control over the light intensity,

the wind speed and humidity beneath its canopy. The accumulation of litter is also favoured. Under well-grown shrubs seedlings of *Poa caespitosa* G. Forst. (snow grass) and, less commonly, ledge grass (see Carr and Turner 1959) are extremely common in many seasons. Where the shrub canopy is dense (building and mature phases) the seedlings die when they are about one inch high, but as the canopy of a shrub begins to thin out, and with the onset of the degenerate phase, grass seedlings at the centre of the base of the shrub persist and grow slowly into 'leggy' weak plants, with long leaf-blades which are much less rigid than those of older plants growing under open conditions. By the time the opening in the canopy is well-defined the grass plants colonizing it have formed small but dense and vigorous tussocks. Colonization by the grass and growth of the tussocks keeps pace with the enlargement of the opening in the shrub canopy so that after a few years the whole area previously covered by the shrub may have become occupied by grass. During this process shelter is afforded the grass by the remaining parts of the shrub.

Where conditions are favourable for the development of grass there is no immediate opportunity for the re-establishment of 'non-rooting' shrubs but, as explained earlier, 'rooting' species may persist in a suppressed state. The establishment of grass in the gap phase of shrub development initiates another cycle of development similar to that described for shrubs. However, by the time the grass has reached the late degenerate and gap phases of its life history, or when a patch of grass is killed by insects (Carr and Turner 1959), the soil surface is covered by a mat of litter, 2 to 6 in. thick. Unless this litter is disturbed no opportunity is provided for the establishment of shrubs from seed. In the normal course of events the grass re-establishes itself by the development of new tussocks from surviving shoots and/or from seed. It takes several years before the grass again provides complete cover. In the meantime herbs grow vigorously in the absence of competition from the grass but are readily suppressed as the tussocks enlarge. Any small shrubs which were present in the original sward also show a marked response to the absence of competition and some individuals may enlarge to such an extent as to shade the grass around them. They thus become dominant and then maintain dominance until they reach the degenerate phase, when an opportunity is again presented for colonization by grass. It must be emphasized that the only time in the life-history of a shrub during which grass seedlings can progress to the tussock-forming stage is during the degenerate phase. A shrub in any earlier phase is proof against invasion. It should also be noted that, although in favourable seasons minute seedlings of grass occur on bare ground they do not persist (Carr and Turner 1959). They are able to grow into tussocks only where shrubs, acting as a nurse crop, provide suitable conditions for their continued development.

The cycle of events just described may be affected by special features of the site. On very immature soils and in places where soil erosion has been severe, formerly suppressed shrubs may grow up to fill the opening which develops in the canopy of the degenerate 'host' shrub. Any grass plants which may have been present are suppressed and eliminated. It is assumed that conditions which allow the development of grass tussocks will not recur until the second-generation shrub becomes degenerate. In fact, in some areas it may take several generations of shrubs to build up the soil to the point where it can support a sward of grass.

On very exposed sites where wind-pruning restricts the height of the shrubs to less than one foot the cycle may follow a somewhat different pattern. In an earlier publication an account was given (Carr and Turner 1959) of the relationship between a rosette herb, *Celmisia longifolia* and three shrub species restricted in height to about 7 in. Briefly, *Celmisia* rhizomes colonized the ground under the

shrubs, its leaves grew up through the canopies before any obvious openings occurred and expansion of the rosettes breached the shrub canopies. In 1959, suppression of shrubs only 11 years old was well-advanced.

In parts of the high plains wind-pruning is not an important factor. On steep E. and S. facing slopes the effects of wind may be very slight and elsewhere small areas are sheltered by large rocks. These areas are usually in snow gum woodland so that additional protection is given by the trees. In such sheltered sites, isolated shrubs are wider and taller than their counterparts in the open. It is more usual to find areas of this kind occupied by closed communities of shrubs. The opportunity for establishment of large numbers of shrubs from seed and the rejuvenation of old shrubs was very great after the 1939 fires when much of the grass cover was destroyed and large areas of bare soil were created. In the first few years the shrubs grew in association with and in increasing competition with the surviving grass plants. The communities were mixed and still open in 1945 and even those subsequently protected from stock remained open until about 1950. Since then enlargement of the shrubs has enabled them to form a closed community. The grass has been suppressed and the shrubs have entered into severe competition with one another. As a result they have grown into tall, elongated plants the individuality of which is not immediately apparent. In some areas such shrubs were as much as 5 ft high in 1959. In these dense stands of shrubs the pattern of orderly development is not as readily apparent as it is in open communities or those in which the shrubs are smaller. On close examination it can be seen that the central branches are losing vigour and that the plants, in fact, are following the normal pattern of development and degeneration. A continuous cover of grasses will probably not develop with the death of the present generation of shrubs in these closed communities as, on the areas they occupy, soil erosion following the 1939 fires was severe. With the death of the existing shrubs grass will probably establish on some of the area, reducing the space available for shrub regeneration. With succeeding generations of shrubs the balance will most likely be tipped more and more in favour of grassy vegetation.

#### Length of Cycle

It was reported earlier (Carr and Turner 1959) that, except in herbfield where special conditions apply, shrub plants commonly take at least 18 years before they show distinct evidence of degeneration. Further observations have confirmed this. *Prostanthera cuneata*, *Phacalium podocarpoides*, *Hovea longifolia* and *Grevillea australis* growing on sites where wind-pruning is moderate usually have a central opening in the canopy when they are 18 to 20 years old. *Grevillea australis* when growing on more exposed sites, often has an intact canopy at 20 years. There is some suggestion that for those species which can tolerate severe conditions, constant wind-pruning may have the effect of maintaining the plant in a vigorous condition and thus prolonging its life beyond that on more sheltered sites. *Orites lancifolia* also tolerates severe wind-pruning and some very large specimens on exposed situations have branches which in 1957 were at least 40 years old. The canopies showed no obvious gaps. Under less severe conditions *Orites* is still longer-lived than the species mentioned above. Many plants known to be 20 years old are still vigorous.

#### The Effects of Trampling

Seedlings at the cotyledon stage are readily destroyed by trampling. Death may result from damage to the shoot or from disturbance of the soil around the root.

Older plants are more resistant but may also be killed by repeated damage (Pl. XXXVIII, fig. 2). From the point of view of maintenance of ground cover any considerable damage to the overground parts of shrubs is serious as dead branches are replaced only very slowly. A comparatively small amount of damage involving the loss of one or two branches may have far-reaching effects because a breach in the canopy of a shrub growing in a wind-swept situation may cause it to lose the smoothness of its aerodynamic profile. The turbulence associated with the opening may be sufficient to cause the partial or complete destruction of the rest of the canopy. Extensive damage to the canopy reduces the microclimate beneath it to a less favourable state, prevents the accumulation of litter and exposes bare ground. It sets the shrub back in development to an earlier stage in its life-history—usually the pioneer phase. This delays the onset of those phases in which replacement by herbaceous species becomes possible. Up to a certain point damage therefore favours the persistence of shrubs. Beyond this point the shrubs cannot make good their losses and die. When they do so bare ground is exposed. In herbfield, the patches of bare ground persist until they are colonized by either shrub seedlings or by a herb (e.g. *Leptorrhynchus*) which spreads by vegetative means (Carr and Turner 1959). In all the other communities under consideration shrubs are the only effective colonists of bare ground, and the open patches persist until seedlings become established or 'rooting shrubs' overgrow them. It is necessary to point out that, although a shrub in the mature phase of its life history may escape damage because it is not attractive to stock and is too tall for them to walk through, once tussocks develop at its centre it is likely to be trampled by stock attempting to graze the grass.

#### The Incidence of Fire and Its Effects on Shrubs

All the available evidence suggests that fire was not an important factor in the area before 1939 (Carr and Turner 1959). This is due, at least in part, to the fact that the grasslands and herbfields do not burn readily. If, however, grasses and herbs are burnt the damage is usually superficial. The bases of the plants and the litter surrounding them remain undisturbed and recovery is rapid. On the other hand, because shrubs burn more fiercely than herbaceous plants, it is common to find that the litter under them burns with the canopy. As recovery is slow, any litter which remains is exposed to the wind and the lighter material blows away. It is therefore common to find that much bare ground is exposed after a shrub community has been burnt. The same is generally true of snow gum woodland. When shrubs isolated in otherwise herbaceous vegetation burn they have the effect of making the fire locally more severe and hence increasing the damage suffered by the sward around them. The size of the patch of bare ground which results is therefore larger than the area originally occupied by the shrub.

In most instances damage to shrubs by the 1939 fire affected only the overground parts and regeneration took place from the base. In some places (the S. side of Mt Cope and on the upper part of Frying Pan Spur) the fire was very severe. Many shrubs were killed and their charred stumps have shown no regeneration.

#### Conclusions

The plant communities of the high plains consist of grasses, herbs and shrubs in varying proportions. Although it is normal for shrubs to occur in all the communities, study of the least-disturbed examples of each kind of community suggests that shrubs are naturally at a minimum on soils which have a deep A horizon and are well-drained. On the other hand, they become prominent in most of the

communities which occur on sites where the water table is high for at least part of the year and also on well-drained sites where the A horizon is shallow (around rock outcrops and on very stony sites). For these and other reasons, it appears that under natural conditions, the presence of shrubs indicated immaturity of the plant communities and of the soils on which they occurred,

From what has been said earlier, it is obvious that on well-drained sites on the high plains there is a natural tendency towards reduction in the amount of shrub cover, because if shrubs are allowed to develop freely they provide conditions which favour the development of grass and not the perpetuation and spread of shrub communities. Wherever snow grass occurs in the area, the soil beneath it shows a complete profile and the A° and litter layers are well-developed. The soils on which shrubs grow do not show this uniformity. In some cases, the soil profile appears to be complete and to have suffered no disturbance, but in other cases, the shrubs are rooted in hollows which lie below the level of the surrounding soil. In the hollows the soil profile is truncated. The litter and A° horizons characteristic of grassland and some of the A horizon are lacking. All gradations between these two extremes may be observed. It appears then, that shrubs may develop in grassland in response to both slight and very severe damage.

Slight disturbance may involve interference with the vegetation only to the extent that the ability of the grass to compete with herbs and shrubs is reduced, but it also includes disturbance of, and removal of part or whole of the litter and A° horizon. Severe damage involves the A horizon of the soil. Slight disturbance is most likely to give rise to rapid alteration in the grass-shrub ratio in communities growing on immature, shallow soils because there the balance between grass and shrubs is delicate. The grass cannot invade and persist on the ground occupied by shrubs unless very special conditions are fulfilled but, on the other hand, if the competitive power of the grass is reduced, the shrubs can encroach on the area occupied by the grass and retain their dominance for many years. Herbs are relatively unimportant in such communities.

On deep mature soils where shrubs are naturally few, shrub dominance takes much longer to develop and, if the damage is slight, shrub dominance is preceded by a stage in which herbs increase in importance. The grass may suffer damage which hinders its development at any stage of its life-cycle, but the most severe and rapid effects result from disturbance during the degenerate phase. The regeneration cycle associated with the life history of the grass involves the intervention of herbs (chiefly *Asperula gunnii* Hk. f.) at the degenerate phase. Once the grass is re-established the herbs are again reduced to insignificance. Under normal circumstances (i.e. those in which there is no disturbance of the dead grass and litter and the grass re-establishes quickly) shrubs take no part in the cycle. Any suppressed shrubs which may be present in the sward grow a little in response to the absence of competition but this is insufficient to allow them to escape severe competition when the grass is re-established. The persistence of very old dwarf shrubs in relatively undisturbed grassland indicates the effectiveness of the control exercised by the grass, the life-cycle of which occupies a much shorter period (approximately 10 years) than that of the shrubs. Disturbance of the dead grass and litter and A° horizon tends to increase the herb component of the sward. It also allows any suppressed shrubs to grow freely so that eventually they may assume local dominance, but it does not provide the conditions necessary for the establishment of shrubs from seed. However, if the disturbance involves actual loss of soil, shrub seedlings may develop, depending to some extent on the community affected.



Shrubs are an important element in the vegetation of the area, if only because of the part they play in the repair processes which are initiated once damage has occurred. The extent to which they are necessary for the regeneration of the vegetation depends on the severity of the previous damage and soil erosion, but their present state of development depends on the amount of trampling, past and present. In those communities which are heavily grazed the trampling factor is sufficient to make the survival of existing shrubs precarious and the establishment of others unlikely, even though there is much bare soil available for colonization. In other communities, less heavily grazed, where shrubs are naturally abundant or have become established following damage, trampling prevents the completion of their life cycle. The immediate result is that in many cases a lack of adequate protection for the soil under and around shrubs. The long-term consequence is that completion of the shrub cycle and, with it, the replacement of woody by herbaceous vegetation, is prevented or indefinitely delayed.

The cure for this is closing the whole area to grazing. One important response to this treatment would be a very great increase in the number and size of the shrubs in the area because (a) shrubs are the only plants which can initiate regeneration in much of the area, and (b) in many of the communities shrubs are already established but are unable to grow normally because of trampling. However undesirable unrestricted growth of shrubs may appear in the short term view, it is essential that it should take place. The free development of shrubs is necessary for the establishment of vegetation on eroded soil and for re-establishing predominantly herbaceous vegetation on the very large area of the high plains which is capable of supporting it.

TABLE 2

*List of species confined to alpine and subalpine areas and which occur on the Bogong High Plains, arranged according to usual habitat*

1. Well-drained sites (grasslands, snow gum woodland, herbfield) :
  - (a) often associated with rock outcrops and rocky slopes, but not confined to them—
    - Drimys xerophila* Parment. (usually only in woodland)
    - Orites laucifolia* F. Muell.
    - Oxylobium alpestre* F. Muell.
    - Phacelium phyllicifolium* F. Muell.
  - (b) grassland, herbfield only—
    - Pimelea biflora* Wakefield (very rare)
  - (c) of general distribution (\* indicates that the species is common on windswept sites)—
    - Bossiaea foliosa* A. Cunn
    - \**Grevillia australis* R. Br.
    - Hclichrysum alpinum* Wakefield
    - \**Lcucopogon hookeri* Sond.
    - \**L. montanus* (R. Br.) J. H. Willis
    - \**Olearia algida* Wakefield
    - O. frostii* (F. Muell.) J. H. Willis
    - O. phlogopappa* (Labill.) DC. var. *subrepanda* (DC.) J. H. Willis
    - Oxylobium ellipticum* R. Br.
    - Pimelea alpina* F. Muell.
    - \**Phacelium podocarpoides* F. Muell.
    - \**Picurandropsis trymalioides* F. Muell.
    - Prostanthera cuccata* Benth.
2. Sites on which soils alternate between very wet and dry, very shallow mossbeds and poorly-drained soils in depressions :
  - Epacris petrophila* Hk. f.
  - Exocarpos nanus* Hk. f. (rare)
  - Kunzea muelleri* Benth.
  - Pentachondra pumila* R. Br.

3. Damp well-drained soils at the foot of slopes:  
*Olearia phlogopappa* (Labill.) DC. var. *flavescens* (Hutch.) J. H. Willis  
*Helichrysum hookeri* (Sond.) Druce
4. Mossbeds:  
*Backea gummiana* Schau.  
*Callistemon sieberi* DC.  
*Exocarpos nanus* Hk. f.  
*Pultenaea fasciculata* Benth.  
*Richea continentis* Burt
5. Riparian or among rocks where water is available at depth:  
*Podocarpus lawrencei* Hk. f.

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#### Explanation of Plate

##### PLATE XXXVIII

- Fig. 1—Central gap in the canopy of plan of *Prostanthera cuneata*. The shrub is 18 years old and has been protected from stock 1945-1957 on the Rocky Valley Plot. (Photograph by courtesy of Mrs L. B. Thrower)
- Fig. 2—Dead branches of shrubs on main cattle-track, photographed 1951. The track was much used until 1945, but has since been more or less neglected except for grazing stock. Regeneration of shrubs is very slow.